THE GENUS *ETIELLA* ZELLER (LEPIDOPTERA: PYRALIDAE): A ZOOGEOGRAPHIC AND TAXONOMIC STUDY

BY

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Pp. 1–21; 15 *Plates*, 1 *Text-figure*, 7 *Maps*

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CONTENTS

SYNOPSIS

The genus *Etiella* Zeller (Lepidoptera, Pyralidae) is redefined and the species in it listed and discussed. Keys to these species, together with maps of their distribution, are given. Four specific synonyms are newly established. The possible phylogeny of the genus is discussed and references to the literature on the biology and control of the Lima-bean Pod-borer, *Etiella zinckenella* (Treitschke) are given.

INTRODUCTION

The genus *Etiella* Zeller (Pyralidae, Phycitinae) contains species whose larvae, where known, feed on the seeds of Leguminous plants. The cosmopolitan species, *Etiella zinckenella* (Treitschke), popularly known as the Lima-bean Pod-borer, is a serious pest of legumes in many parts of the world. Although the present work is primarily a zoogeographic and taxonomic study of the genus, references to the biology and insecticide control of recent years are also given.

The definition of the genus on page 9 restricts the number of species to seven; no new species is described here and nine species are transferred to other genera. One of the more difficult problems has been the generic placing of the species removed from the genus. In spite of considerable effort, the placing of these species in this work must be regarded as provisional. They may be more accurately placed when other genera of Phycitinae are revised.

The problems of the Phycitinae and their identification were summarized by Heinrich (1956 : vi), who wrote 'So many misidentifications have been made in the past, even by Lepidopterists of repute, that records in the literature cannot be accepted merely on the authority of the author'. This is as true in *Etiella* as in the other genera in the subfamily and therefore no previously published records of the genus have been accepted unless they were accompanied by clearly recognizable figures. Although we can be reasonably certain that only *E. zinckenella* has been found on some continents, each record there still requires critical examination.

Most of the type-specimens of the species described in *Etiella* have been examined; in cases where these were not available topotypic material was used. The type-specimens of all the presently valid species in the genus have been examined. Wing measurements given are taken from the apex of the fore wing to the centre of the mesothorax. Wing span is thus approximately twice this figure.

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ABBREVIATIONS

AMNH	American Museum of Natural History, New York.
ANIC	Australian National Insect Collection, C.S.I.R.O., Canberra.
BMNH	British Museum (Natural History).
BPBM	Bernice P. Bishop Museum, Honolulu.
MNHN	Muséum National d'Histoire Naturelle, Paris.
SAM	South Australian Museum, Adelaide.
TM	Természettudományi Múzeum, Budapest.

CHECK-LIST OF SPECIES OF *ETIELLA* ZELLER

E. scitivittalis (Walker) **sp. rev.**
sincerella Meyrick **syn. n.**
E. chrysoporella Meyrick
E. grisea grisea Hampson
E. grisea drososcia Meyrick **stat. n.**
E. hobsoni (Butler)
melanella Hampson **syn. n.**

E. walsinghamella Ragonot
flavofasciella Inoue **syn. n.**
E. zinckenella (Treitschke)
anticalis Walker
**colonnellus* Costa
dymnusalis Walker
**zinckenella* ab. *decipiens* Staudinger
etiella Treitschke
hastiferella Walker
heraldella Guenée
indicatalis Walker
**madagascariensis* Saalmüller
**majorellus* Costa
**rubribasella* Hulst
sabulinus Butler
schisticolor Zeller
**spartiella* Rondani
**villosella* Hulst
E. behrii (Zeller)
subaurella Walker
consociella Walker
ochristrigella Ragonot **syn. n.**

SPECIES TRANSFERRED FROM *ETIELLA* ZELLER

The following species, originally described in *Etiella*, have been transferred to the genera indicated. All their holotypes have been examined.

Assara albicostalis (Walker), transferred by Roesler, 1965, Inaugural Dissertation der Universität des Saarlandes, Saarbrücken.
Nephopterix furella (Strand) **comb. n.**
Nephopterix fuscalis (Kenrich) **comb. n.**
Hypogryphia holozona (Lower) **comb. n.** Very close to *H. rufifasciella* Hampson.
Staudingeria ifraneella (Lucas) **comb. n.** The holotype is a female and the generic position of this species is uncertain.
Cryptoblabes myosticta (Hampson) **comb. n.**
Catastia uniformalis (Hampson) **comb. n.**
Phycita venustella (Hampson) **comb. n.**
Epischnia yangtseella (Caradja) **comb. n.**

GEOGRAPHICAL DISTRIBUTION

Maps 1–7 show the distribution of each species. Except for *E. zinckenella* the species of the genus are restricted to the Australasian and part of the Oriental regions, with one of these species occurring in Japan.

*Holotype or paratype not examined, topotypic material studied.

A small collection from Monte Bello Is. (West Australia), made in 1952, contained a short series of *Etiella* specimens. These have proved to include three species (*behrii, chrysoporella, grisea*). While the former two are widespread Australian species, the latter is otherwise known only from one specimen on the mainland at Wyndham (Western Australia).

E. scitivittalis is restricted to Australia while *E. chrysoporella* is known only from Australia and the island of Tanimber in the Arafura Sea. *E. grisea* is widespread over the Pacific and, while not yet recorded from Java and Sumatra, occurs in Ceylon. Although the genitalia of all the specimens of *grisea* examined were similar, there is some local variation in pattern and colour. In Ceylon the specimens are pale grey while on Tanimber, the only two specimens examined are much blacker than the other specimens. In spite of wide separation of the populations of this species from the Society Islands to the Marianas, no constant differences in morphology have been found between most of these island populations.

E. hobsoni is widely distributed with, at present, few records from New Guinea and none from Celebes. Specimens from Formosa differ only slightly in pattern from the Australian specimens and, on the few specimens examined, cannot be separated subspecifically.

E. walsinghamella has a similar distribution to *hobsoni* but is less widely distributed in Australia, while extending through the East Indies right up to Japan. Differentiation is again slight over the whole range with some pattern differences but, on the material examined, this is not constant. *E. walsinghamella* is very distinct in external colour and pattern from *E. zinckenella* but the rest of the morphology and genitalia in both sexes are similar in these two species. It seems probable that *walsinghamella* and *zinckenella* are derived only recently from a common ancestor, from which they have only slightly differentiated.

E. zinckenella is pantropical, but in the present work specimens have not been seen from New Zealand or Hawaii, nor from many of the central Pacific Islands. *E. zinckenella* is widespread in Nearctic, Neotropical, Ethiopian, Oriental and southern Palaearctic regions and in the northern part of Australia and some Pacific Islands, including Samoa. In spite of being widespread, with much variation in size and colour over the whole range, there is no evidence of local populations differentiating on morphological grounds and it seems likely that its spread has been both rapid and relatively recent and probably assisted by man. Another factor with this species is its own inherent ability for widespread dispersion. Stone (1965 : 16) comments that 'the moths are strong fliers and capable of migrating long distances to reach their host-plant.' Certainly this is amongst the most widespread of any species of moth which has not apparently subspeciated over any part of its range.

E. behrii has been recorded in the literature (e.g., Vesey-Fitzgerald, 1941) from outside the range shown in map 7. Most of these specimens have been re-examined and all have proved to be *zinckenella*. At present the range of *behrii* is more restricted than *zinckenella* although it may well prove to have a similar explosive spread-potential and to become more widespread.

PHYLOGENY

No fossil evidence is available for consideration of the evolution of this genus and only biological and morphological evidence is used in the following discussion.

The genus consists of two groups of species with different types of distribution

1. World-wide (one species).
2. Mainly Australasian or Oriental (six species).

If the genus is monophyletic there are two ways of considering its phylogeny.

a. The species in the first group, having spread widely from 'a centre of origin', speciated in the Oriental-Australasian region. This is analagous to a widespread species arriving on, for example Hawaii, and then radiating and eventually producing many new species. Cases of this type of peripheral or island speciation are well documented (e.g. Zimmerman, 1970).

b. Conversely, the widespread species arose from a species in the Oriental-Australasian region which then spread rapidly round the tropics.

From morphological studies, the world-wide species (*zinckenella*) shows more specialized features than some of the species of more restricted distribution. The extreme modification of the costa of the valve in the male and the enormous secondary sac on the bursa of the female can be considered the end points arising from species where these characters are present in a less developed condition. For the alternative argument, that the 'simpler' ones arose by reduction of the characters of the wide-spread species, no supporting evidence has been found in any related genus, which seems otherwise morphologically closer to *Etiella*, where these specializations do not occur. In one species (*scitivittalis*) the characters of the genus are present in the least developed form and this species is known at present only from Australia. From this species a series showing gradual development of these characters can be drawn from the species in the genus.

If the genus arose by rapid speciation in the Australasian region of the more widespread species by gradual reduction of the various characters, one must assume that a reduced state is more specialized. As already mentioned, no supporting evidence for this has been found in other genera. For example, the long costal process on the valve of the male is unusual and the evidence suggests that the less specialized condition of the valve is the more general (? primitive) form.

In the absence of other evidence, I consider that the genus is Australasian in origin and that one species has been particularly successful, showing explosive spreading throughout the world between 50° north and 50° south.

The genus *Etiella* is allied to *Pima* Hulst, whose larvae also feed on leguminous seeds, but its actual relationship to this and other Phycitid genera will have to wait for further studies on them. Within the genus *Etiella* a possible phyletic relation can be represented by the morphoseries shown in Text-fig. 1.

BIOLOGY

E. zinckenella is a pest of pods of legumes. It has been recorded from 30 species in 21 genera of legumes (Naito, 1961) but few records have been published of hosts other than legumes (e.g., Viktorov, 1938, on water melons). Many accounts of the

biology and life-history of this species have been published and a selection of them is given in the references. Data on the other species in the genus is more limited but all the recorded hosts are species of legumes. The species in the genus appear to have specialised in feeding on the seeds of these plants. For further information on the biology and control measures of *E. zinckenella*, see Issiki, 1969, (coloured figures of the larvae); Kruel, 1963 (occurrence in Germany); Naito, 1961 (biology and distribution); Oatman, 1967 (biology in the U.S.A.); Peiu, 1966 (biology in Roumania); Schad, 1943 (biology in France); Stone, 1965 (biology and control measures in the U.S.A.).

Details of host plants are given in the section 'Biology' under each species.

ETIELLA Zeller, 1839

Etiella Zeller, 1839 : 733. Type-species: *Phycis zinckenella* Treitschke, by monotypy.
Rhamphodes Guenée, 1845 : 319. Type-species: *Phycis etiella* Treitschke, by monotypy.
Mella Walker, 1859 : 1017. Type-species: *Mella dymnusalis* Walker, by monotypy.
Alata Walker, 1863 : 108. Type-species: *Alata anticella* Walker, by monotypy.
Arucha Walker, 1863 : 201. Type-species: *Arucha indicatalis* Walker, by monotypy.
Modiana Walker, 1863 : 82. Type-species: *Modiana scitivittalis* Walker, by monotypy.
Ceratamma Butler, 1880 : 689. Type-species: *Ceratamma hobsoni* Butler, by original designation.

The synonymy given in the Catalogue of the genera of Phycitinae (Whalley, 1970 : 45) has been checked. Although the synonymy remains the same, the genus, which has often been attributed to Zeller, 1846, is here referred to his usage of 1839; (in this work Zeller refers to it as a subgenus of *Pempelia* Hübner, 1825), this is the date used by Heinrich, 1956.

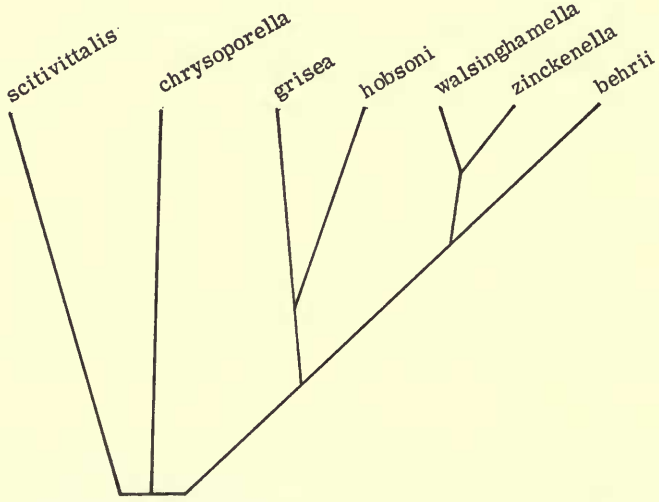

FIG. 1. Suggested relationship of species in *Etiella* Zeller. (See p. 7)

Antennae of male with basal segment enlarged with variable shaped projection on inner margin near base. Shaft with sinus containing long scales. Labial palps very long, usually 2 or more times diameter of eye. Second segment of labial palps grooved to hold aigrette-like maxillary palps. Maxilliary palps of female smaller; third segment of labial palp longer than in male. Fore wing often with ridge of raised scales in antemedian position. Eleven fore wing veins. Hind wing with M_2 and M_3 joined. Eighth segment of male with small hair-tufts Uncus hood-like. Gnathus a simple sharp hook. Valve usually with strongly sclerotized costal process. Aedeagus with strongly sclerotized and spiny vesica with cornuti. Female with bursa elongate, usually with many-spined signum, secondary sac (see Pl. 10, figs 66, 68 and 76, indicated by 's') usually sclerotized, coming off bursa near junction of ductus bursae. Ductus seminalis arising from various positions on bursa, often from near origin of secondary sac.

Key to Males

1		Juxta with elongate, pointed and sclerotized arms (Pl. 5, figs 26 and 30) . .	2
–		Juxta blunt-ended, usually with apical hairs on each lobe	3
2	(1)	One costal valve process long, sclerotized, other costal process reduced but visible as sclerotized point. (Pl. 5, fig. 30) . . . ***chrysoporella*** (p. 11)	
–		Both valves with very reduced processes, visible only as small, lightly sclerotized processes (Pl. 5, fig. 25) . . . . . ***scitivittalis*** (p. 10)	
3	(1)	Both costal valve processes long, sometimes one slightly shorter than other .	4
–		One valve process very reduced, less than half length of other (Pl. 6, fig. 36) . . . . . ***grisea*** (p. 11)	
4	(3)	Juxta lobes long and slender (Pl. 8, fig. 55). Valve approximately diamond-shaped (Pl. 8, fig. 57) . . . . . ***behrii*** (p. 17)	
–		Juxta lobes not as above, often swollen at apex, valve often elongate and thin	5
5	(4)	Fore wings reddish brown, without white costal streak. Broad yellow-orange median fascia. Hind wings black or dark grey. Genitalia as in Pl. 7, figs 44–49 . . . . . ***walsinghamella*** (p. 14)	
–		Fore wings with or without white costal streak. If without streak, fore wings black or dark brown; if with streak, fore wings varying from pale buff to almost black. Antemedian fascia narrow	6
6	(5)	White costal streak. Grey-brown, buff or nearly black fore wings. Very variable in size. Genitalia as in Pl. 8, fig. 50 . . . ***zinckenella*** (p. 15)	
–		White costal streak very indistinct or absent. General colour of fore wings black or dark reddish brown. Hind wings dark. Genitalia as in Pl. 7, fig. 40 . . . . . ***hobsoni*** (p. 13)	

Key to Females

1		No sclerotized secondary sac on bursa nor sac attached to bursa by duct (Pl. 10, fig. 65) . . . . . ***scitivittalis*** (p. 10)	
–		Secondary sac on bursa or attached by long duct. Secondary sac usually heavily sclerotized	2
2	(1)	Duct of bursa short (Pl. 10, figs 66, 76) usually wider than long . . .	3
–		Duct of bursa much longer than width	4
3	(2)	Ductus seminalis from near middle of bursa. Small sclerotized platelets in broader first part of ductus seminalis. Secondary sac a sclerotized lobe on bursa (Pl. 10, fig. 66) . . . . . ***chrysoporella*** (p. 11)	
–		Ductus seminalis opening nearer bottom of bursa away from ductus bursae. Spines in ductus seminalis. Secondary sac at end of long duct (Pl. 10, fig. 76) . . . . . ***behrii*** (p. 17)	
4	(2)	First part of ductus seminalis with small spines or sclerotized plates . .	5
–		First part of ductus seminalis without spines or sclerotized plates, duct often strongly folded	6

5 (4) Signum a row of long spines, clearly visible (Pl. 14, fig. 96) . . ***hobsoni*** (p. 13)
– Signum of smaller spines, or signum indistinct (Pl. 14, fig. 95) . ***grisea*** (p. 12)
6 (4) Ductus bursae heavily sclerotized with long striae. Ostium heavily sclerotized. Secondary sac clearly without sclerotized spines . ***walsinghamella*** (p. 14)
– Ductus bursae less heavily sclerotized. Ostium lightly sclerotized. Secondary sac clearly with sclerotized spines . . . . . ***zinckenella*** (p. 15)

TAXONOMIC SECTION

Etiella scitivittalis (Walker) sp. rev.

(Pl. 1, fig. 1; Pl. 5, figs 25–29; Pl. 10, fig. 65; Pl. 12, fig. 83; Pl. 14, fig. 93)

Modiana scitivittalis Walker, 1863 : 83. Holotype ♂, AUSTRALIA (BMNH) [examined].
Etiella sincerella Meyrick, 1879 : 204. Holotype ♂, AUSTRALIA (BMNH) [examined]. **Syn. n.**
Etiella sincerella Meyrick; Ragonot, 1893 : 571.
[*Etiella zinckenella* (Treitschke) sensu Ragonot, 1893 : 572, misidentification.]

♂. Wing, 14–16 mm. Labial palps 3 × diameter of eye. Third segment of labial palp less than ¼ length of second. Fore wing, pattern as in Pl. 1, fig. 1, reddish brown behind white costal streak. Orange-brown transverse antemedial fascia. Hind wings smoky grey.

Genitalia ♂ (Pl. 5, figs 25–29). Valves with costal margin thickened, process on costa a single short lobe on each valve. Juxta with two sclerotized lateral lobes, curved and pointed. Aedeagus with large cornuti.

♀. Wing, 11–15 mm. Third segment of labial palp longer than in male. Pattern and colour similar.

Genitalia ♀ (Pl. 10, fig. 65; Pl. 12, fig. 83; Pl. 14, fig. 93). Signum a row of long spines. No sclerotized secondary sac on bursa. Ductus seminalis with minute platelets, broad, arising from near middle of bursa.

DISCUSSION. This is the largest species in the genus and is easily recognized by the size and warm reddish brown colour of the fore wings behind the white costal streak. The costal margin of the valve in the male is heavily sclerotized but with only a small process from the margin. The valve also has a small raised papilla half way along the length just below the costa, this papilla is covered with stout spines. An homologous area in the other species also has the stout spines but is without the raised papillae. The juxta is similar to *chrysoporella* and the aedeagus is typical of the genus. The female differs from all the others in the genus in the lack of the secondary sac on the bursa. From the position where the ductus bursae enters the bursa there is a trace of the first stages of a secondary sac.

BIOLOGY. No information.

DISTRIBUTION. Map 1. Australia, Queensland, New South Wales.

MATERIAL EXAMINED.

Holotype ♂ (*scitivittalis*), AUSTRALIA: Moreton Bay, BM slide no. 13056, in BMNH. Holotype ♂ (*sincerella*), AUSTRALIA: Sydney, N.S.W., G.H.R., ix.[18]78, BM slide no. 13254, in BMNH. 18 specimens, SAM, Adelaide. 5 specimens, BMNH. 8 specimens, ANIC, Canberra.

Etiella chrysoporella Meyrick

(Pl. 1, figs 2, 4; Pl. 5, figs 30, 31; Pl. 10, fig. 66; Pl. 11, fig. 77; Pl. 14, fig. 94)

Etiella chrysoporella Meyrick, 1879 : 206. LECTOTYPE ♂, AUSTRALIA (BMNH), here designated [examined].

Etiella chrysoporella Meyrick; Ragonot, 1893 : 576.

♂. Wing, 8–12 mm. Fore wing pattern as in Pl. 1, fig. 2, brown with golden iridescence. Spots on antemedial fascia edged with black. White streaks between veins subterminally. Usually a white streak from basal area below posterior margin of cell. Costal streak white. Hind wings pale smoky brown.

Genitalia ♂ (Pl. 5, figs 30, 31). Costal process of valve modified, one process shorter than other. Juxta with strongly sclerotized and pointed lateral arms. Aedeagus with cornuti similar to *zinckenella*.

♀. Wings, 8–12 mm. Colour and pattern as male. Third segment of labial palps longer than in male.

Genitalia ♀ (Pl. 10, fig. 66; Pl. 11, fig. 77; Pl. 14, fig. 94). Ductus bursae short, lightly sclerotized. Secondary sac on bursa large, heavily spined near junction with bursa. Bursa with row of long spines. Ductus seminalis, with small sclerotized platelets inside, arising from near middle of bursa.

DISCUSSION. Specimens from Tanimber do not differ from those from the mainland of Australia. The bright iridescent colours and particularly the more numerous white streaks on the fore wing separate this species from the others in the genus.

BIOLOGY. No information.

DISTRIBUTION. Map 2. Australia, Queensland, South Australia, Northern Territory, Western Australia; Indonesia, Tanimber.

MATERIAL EXAMINED.

Lectotype ♂, AUSTRALIA: Adelaide, S. Australia, 15.x.[18]82, Meyrick coll. BM slide no. 13208, in BMNH. 40 specimens, BMNH. 35 specimens, SAM, Adelaide. 8 specimens, ANIC, Canberra.

Etiella grisea Hampson

Etiella grisea Hampson, 1903 : 33.

This species varies from grey to a rather blackish brown colour on the fore wings. It is characterized in the male by the reduction of one of the costal valve processes to a short spine. In the female the spines of the signum, which are characteristic of the other species in the genus, are reduced or absent in *grisea*. The ductus seminalis in the male is broad and the first part of it from the bursa has small sclerotized platelets inside.

E. grisea is widely distributed from Ceylon to Tahiti. The Ceylon specimens are grey in colour whereas those over the rest of the range tend to be more grey-brown. On Tanimber the only two specimens examined have a much darker fore wing than any of the other specimens and could represent a distinct subspecies; the single

specimen from Monte Bello Island (Western Australia) is also slightly different from the others. The series from Ceylon is constant in pattern and has already been named by Hampson, the remaining specimens are grouped with the species Meyrick described from Tahiti. In spite of wide separation of island populations no differences were found in the morphology of the genitalia, even the Ceylon specimens were similar.

KEY TO THE SUBSPECIES OF *E. grisea* Hampson

Pale grey fore wing, sometimes with transverse fascia. Ceylon . ***grisea grisea*** (p. 12)
Grey or grey-brown fore wing, sometimes with transverse fascia, occasionally with traces of white costal streak. Australian-Pacific . . . . ***grisea drososcia*** (p. 13)

Etiella grisea grisea Hampson

(Pl. 1, fig. 3; Pl. 6, figs 32–35; Pl. 10, fig. 67; Pl. 14, fig. 95)

Etiella grisea Hampson, 1903 : 33. LECTOTYPE ♂, CEYLON (BMNH), here designated [examined].

♂. Wing, 10–12 mm. Labial palps 3 × diameter of eye, third segment one quarter length of second. Fore wing pattern as in Pl. 1, fig. 3, pale grey with darker, transverse, antemedial fascia.

Genitalia ♂ (Pl. 6, figs 32–35). Juxta with elongate lateral lobes slightly clavate at apex. One valve with very short costal process, other valve with long costal process. Aedeagus with spiny, sclerotized vesica with two large sclerotized patches.

♀. Wing, 8·5–10 mm. Labial palps with third segment half length of second. Fore wing with slightly less distinct pattern than male.

Genitalia ♀ (Pl. 10, fig. 67; Pl. 14, fig. 95). Duct of bursa sclerotized, long and strongly ribbed. Sclerotized signum with small spines, small patch of spines on secondary sac of bursa. Ductus seminalis arising from nearer centre of bursa, enlarged at origin with bursa and with small platelets inside.

DISCUSSION. This subspecies is known only from Ceylon. The morphology of the genitalia is similar to *grisea drososcia* and this latter subspecies has some specimens almost as pale as those from Ceylon, but generally the specimens from Ceylon are separable from the other by their paler grey colour.

BIOLOGY. No information.

DISTRIBUTION. Map 3. Ceylon.

MATERIAL EXAMINED.

Lectotype ♂, CEYLON, 95.91, BM slide no. 13294, in BMNH. 12 specimens, BMNH.

Etiella grisea drososcia Meyrick **stat. n.**

(Pl. 1, figs 5, 6; Pl. 6, figs 36–39; Pl. 10, fig 68; Pl. 11, fig. 80; Pl. 12, figs 85, 87)

Etiella drososcia Meyrick, 1929 : 158. LECTOTYPE ♂, TAHITI (BMNH), [examined].
[*Etiella zinckenella* (Treitschke) sensu Tams, 1935 : 254, misidentification.]

♂. Wing, 9–14 mm. Head as nominate subspecies. Fore wing, pattern as in Pl. 1, figs 5, 6, grey or grey-brown with light coloured costal streak. Wings variably marked, often with black spots on indistinct antemedial fascia.

Genitalia ♂ (Pl. 6, figs 36–39). As nominate subspecies.

♀. Wing, 11–12·5 mm. Pattern and colour as male. Third segment of labial palp half length of second.

Genitalia ♀ (Pl. 10, fig. 68; Pl. 11, fig. 80; Pl. 12, figs 85, 87). As nominate subspecies.

DISCUSSION. The two specimens from Tanimber are much blacker than the others and the single male from Prince of Wales Is. (N. Australia) is slightly larger than the other specimens. The only specimen from the mainland of Australia is a female from Wyndham (W. Australia). The pattern and the distinctness of the median fascia are equally variable over the whole of the range of this subspecies. It is probable that this species is widespread over most Pacific islands; so far no specimens have been seen from Java or Sumatra. It is interesting to speculate whether, since this subspecies is known from pods of legumes, it enters into competition with the widespread *zinckenella*. Will this latter species eventually spread to all the islands and replace *grisea* or will *grisea* become commoner? In Ceylon and other places the two species occur together, but there is no information on the detailed ecology of *grisea*.

BIOLOGY. This subspecies has been bred from the pods of *Vigna* (Leguminosae) in Fiji and from *Crotalaria* pods (Leguminosae) in Guam.

DISTRIBUTION. Map 3. Society Is., Tahiti; Cook Is., Rarotonga; Samoa; Fiji; New Hebrides; Solomon Is., St. Cristobal; Australia, Prince of Wales Is., Monte Bello Is., West Australia; Indonesia, Tanimber; New Guinea; Caroline Is., Truk; Mariana Is., Guam.

MATERIAL EXAMINED.

Lectotype ♂: TAHITI: nr. Papeete, iii–iv. 1925 (*Cheesman*), BM slide no. 13245, in BMNH. 12 specimens, BMNH. 30 specimens, BPBM, Honolulu. 2 specimens, ANIC, Canberra.

Etiella hobsoni (Butler)

(Pl. 2, figs 7–9; Pl. 7, figs 40–43; Pl. 10, figs 69–71; Pl. 11, fig. 78; Pl. 13, figs 88, 89; Pl. 14, figs 96–98)

Ceratamma hobsoni Butler, 1880 : 689. LECTOTYPE ♂, FORMOSA (BMNH), here designated [examined].
Etiella hobsoni Butler; Ragonot, 1893 : 578.
Etiella hobsoni Butler; Shibuya, 1928 : 94.
Etiella melanella Hampson & Ragonot, 1901 : 558, Holotype ♂, AUSTRALIA (BMNH), [examined].
Syn. n.
Etiella hopsoni, misspelling, Caradja, 1939 : 20.

♂. Wing, 7–9 mm. Labial palps 2½ × diameter of eye, third segment one third length of second. Fore wing, pattern as in Pl. 2, figs 7–9, grey-black with brown or black transverse fascia. Hind wings smoky grey.

Genitalia ♂ (Pl. 7, figs 40–43). Costal process of valve on one side 1¼ × length of other side Juxta lightly sclerotized, apex swollen and hairy. Aedeagus with two large cornuti.

♀. Wing, 7–10 mm. Colour and pattern as male.

Genitalia ♀ (Pl. 10, figs 69–71; Pl. 11, fig. 78; Pl. 13, figs 88, 89; Pl. 14, figs 96–98). Ductus bursae heavily sclerotized with prominent longitudinal ribbing. Ductus seminalis with small platelets with very broad opening near centre of bursa.

Discussion. This small species is similar externally to *walsinghamella* but lacks the prominent yellow-orange fascia of that species and has black, not reddish fore wings. The main variation between specimens of *hobsoni* is in the colour, or the presence of, the transverse fascia of the fore wing. Some specimens are without this fascia, others have it in a very incomplete form. There is little other morphological variation between specimens from as far apart as Formosa and Australia.

Biology. No information.

Distribution. Map 4. Australia, Queensland, Northern Territory, South Australia; New Guinea; Solomon Is.; New Britain; Caroline Is., Truk; Indonesia, Wetar, Timor; Formosa.

Material examined.

Lectotype ♂ (*hobsoni*), Formosa, 80–115, BM slide no. 13247, in BMNH. Holotype ♂ (*melanella*), Australia: Adelaide, vii. [18]91, BM slide no. 13270, in BMNH. 25 specimens, BMNH. 1 specimen, SAM, Adelaide. 32 specimens, BPBM, Honolulu.

Etiella walsinghamella Ragonot

(Pl. 2, figs 10–12; Pl. 7, figs 46–49; Pl. 10, figs 72–74; Pl. 13, figs 90–92; Pl. 15, figs 99–101)

Etiella walsinghamella Ragonot, 1888 : 27. Holotype ♂, New Guinea (BMNH) [examined].
Etiella walsinghamella Ragonot; Ragonot, 1893 : 577.
Etiella flavofasciella Inoue, 1959 : 299, Holotype ♂, Japan (Kyushu University Coll., Japan). [not examined]. **Syn. n.**

♂. Wing, 8–12 mm. Labial palps 3¼ × diameter of eye, third segment less than one quarter of second. Fore wing, pattern as in Pl. 2, figs 10–12, brown or reddish brown with yellow-orange fascia. Hind wings smoky grey.

Genitalia ♂ (Pl. 7, figs 46–49). Similar to *zinckenella*. Valve with slightly less slender apex. Aedeagus with cornuti more slender than *zinckenella*.

♀. Wing, 8–11 mm. Pattern as male but with fore wings usually with more red scales and hind wings darker, almost black. Narrow median fascia usually present on fore wing.

Genitalia ♀ (Pl. 10, figs 72–74; Pl. 13, figs 90–92; Pl. 15, figs 99–101). Similar to *zinckenella*, signum longer in proportion to total length of bursa and ductus bursae usually longer in *walsinghamella* than *zinckenella*.

Discussion. Externally the pattern and general appearance of this species separate it from *zinckenella* but the genitalia of these two species are similar. The

male of *walsinghamella* has shorter costal processes on the valve and the juxta lobes are blunter at the apex than *zinckenella*. In the females, the ductus bursae and signum are longer in *walsinghamella* than *zinckenella* (not clear in figs 74, 75 due to slight differences in magnification). *E. walsinghamella* is closely related to *zinckenella* and has only diverged slightly from it. No overlap in pattern between these two species has been found but some of the specimens of *zinckenella* from New Guinea approach *walsinghamella* in general colour. Within the material of *walsinghamella* examined, the Australian and Japanese specimens are larger than those from New Guinea, with more red in the fore wing but there is an overlap in these characters and no clear subspecific trend on external characters is shown.

BIOLOGY. No information.

DISTRIBUTION. Map 5. Australia, Queensland; New Guinea; Japan.

MATERIAL EXAMINED.

Holotype ♂ (*walsinghamella*), NEW GUINEA (specimen lacks abdomen), in BMNH. Paratype ♂ and ♀ (*flavofasciella*), JAPAN: Orio, Fukuoka Pref., 28.viii.1958 (*Kawamura*), in BMNH. 8 specimens, BMNH. 8 specimens, SAM, Adelaide. 1 specimen, BPBM, Honolulu.

Etiella zinckenella (Treitschke)

(Pl. 3, figs 13–18; Pl. 4, figs 23, 24; Pl. 8, figs 50–54, 56; Pl. 9, fig. 64; Pl. 10, fig. 75; Pl. 11, fig. 79; Pl. 15, fig. 102)

Phycis zinckenella Treitschke, 1832 : 201. Lectotype ♀, SICILY (TM) [examined].
Phycis etiella Treitschke, 1835 : 174 [unnecessary replacement name].
Pempelia Etiella zinckenella (Treitschke); Zeller, 1839 : 179.
Rhamphodes zinckenella (Treitschke); Guenée, 1845 : 319.
Rhamphodes etiella (Treitschke); Guenée, 1846 : 81.
Etiella zinckenella (Treitschke); Zeller, 1846 : 733.
Etiella zinckenella (Treitschke); Heinemann, 1865 : 154.
Chilo colonnellus Costa, [1836] : [243]. Type, ITALY [type-series not traced].
Chilo majorellus Costa, [1836] : [241]. Holotype ♂, ITALY [type-series not traced].
Mella dymnusalis Walker, 1859 : 1018. Holotype ♀, SIERRA LEONE (BMNH) [examined].
Rhamphodes heraldella Guenée, 1862 : G.72. Holotype ♂, REUNION (MNHN) [not examined].
Alata anticalis Walker, 1863 : 108. LECTOTYPE ♂, CHILE (BMNH) here designated [examined].
Arucha indicatalis Walker, 1863 : 202. Holotype ♂, SOUTH AFRICA (BMNH) [examined].
Alata hastiferella Walker, 1866 : 1725. Holotype ♂, GRENADA (BMNH) [examined].
Etiella zinckenella ab. *decipiens* Staudinger, 1870 : 195. Type? EUROPE, [type-series not traced].
Etiella spartiella Rondani, 1876 : 19 Holotype ♂ [ITALY?], [not examined].
Crambus sabulinus Butler, 1879 : 455. Holotype ♂, JAPAN (BMNH), [examined].
Etiella madagascariensis Saalmüller, 1879–80 : 307. Type, MADAGASCAR [type-series not traced].
Etiella zinckenella (Treitschke); Meyrick, 1879 : 203.
Etiella schisticolor Zeller, 1881 : 178. LECTOTYPE ♂, U.S.A. (BMNH), here designated [examined].

Etiella zinckenella (Treitschke); Meyrick, 1883 : 156.
Etiella villosella Hulst, 1887 : 133. Holotype ♂, U.S.A. (AMNH) [not examined].
Etiella zinckenella (Treitschke); Hulst, 1890 : 169.
Etiella rubribasella Hulst, 1890: 170. Holotype ♂, U.S.A., (AMNH) [not examined].
Etiella zinckenella (Treitschke); Ragonot, 1893 : 572.
Etiella zinckenella (Treitschke); Hampson, 1896 : 108.
[*Etiella scitivittalis* (Walker) sensu Hampson, 1896 : 108, misidentification.]
Etiella zinckenella (Treitschke); Oberthür, 1922 : 333.
Etiella zinckenella (Treitschke); Shibuya, 1928 : 93, partim.
Etiella zinckenella (Treitschke); Janse, 1944 : 15.
Etiella zinckenella (Treitschke); Heinrich, 1956 : 99.
Etiella zinckenella (Treitschke); Commonwealth Institute of Entomology, 1959, Map 105.
Etiella zinckenella (Treitschke); Whalley, 1970 : 45.

♂. Wing, 10–15 mm. Labial palps 3 × diameter of eye. Fore wing, pattern as in Pl. 3, figs 13–18, variably coloured, red-brown to black-brown. White costal streak usually present. Antemedial fascia orange-brown to orange-red, fascia edged with black on antemedial side, frequently gold iridescence on fascia.

Genitalia ♂ (Pl. 8, figs 50–54, 56; Pl. 9, fig. 64). Costal processes on valves long. Juxta with two broad, elongate, lateral lobes, rounded at apex. Aedeagus with large sclerotized cornuti in vesica and many small spines.

♀. Wing, 6–15 mm. Third segment of labial palp longer than male. Colour and pattern similar.

Genitalia ♀ (Pl. 10, fig. 75; Pl. 11, fig. 79; Pl. 15, fig. 102). Ductus bursae long, sclerotized, tapering slightly towards opening with bursa. Secondary sac large, sclerotized, containing spines. Large spiny signum on main bursal sac. Ductus seminalis, without platelets inside, arising near origin of ductus bursae and bursa itself.

Discussion. This species is common in most tropical and many temperate countries, where it is a pest of legumes. Specimens of *zinckenella* vary considerably in size and, to a lesser extent, in colour, although the pattern is fairly constant. There is a tendency for specimens from North America to be greyer than those from the rest of the world but this is by no means constant. The only other small difference between Old and New World specimens is in the length of the ductus bursae of the female; this is slightly shorter in the American specimens than in the others, but again this is not constant, some overlap occurring. In Morocco some large dark specimens were included in a series of more normally coloured ones, although no other differences could be found in this series and the genitalia were typical of the species. A series of specimens from Egypt were smaller and more sandy coloured than the more typical red or black-brown. From the rest of the African continent there is a wide range of size and colour variants with series of particularly small specimens from Madagascar. Specimens from the Indian subcontinent, Malaya, China, and Japan were similar to those from the Mediterranean region. In Indonesia some variation was found in wing colour but in New Guinea a distinct form occurs with dark hind wings, instead of the more typical pale smoky brown ones. Over the rest of the range a few specimens were found with this darker hind wing but the New Guinea specimens and some from the Solomon Islands were very dark. No other differences have been found between these specimens of *zinckenella*, no evidence of seasonal or food-plant forms were found but the data was mostly too fragmentary to examine this aspect. In most specimens the genitalia

were similar, little intra-specific variation was found although certain structures varied slightly. These were the length of the costal processes of the males, the shape and extent of the spines in the vesica and in the females in the extent of the signum. Variation in all these characters was found equally in specimens from all parts of the range of *zinckenella*.

Biology. Pest of seeds of legumes throughout the world, recorded from 30 species of 21 genera (Naito, 1961). Detailed accounts of the biology and larvae will be found in Naito (1961), Oatman (1967) and Stone (1968). The eggs are laid in the seed-pod of the legume and the larvae bore into the pods, feeding on the seeds. Figures for the length of life-cycle vary but Stone (1968) gives from 2 months to 9·9 months at 61°F. The larvae, after feeding on the seeds, bite their way out and pupate in the soil, forming a small cocoon of soil.

Specimens have been examined from all the countries in the following list. Although I have not seen the Costa types (*majorellus*, *colonnellus*) I have examined topotypic material and I agree with Zeller (1846 : 751) that these two are just re-descriptions of *zinckenella*.

Distribution. Map 6. All Mediterranean countries and Black Sea area; Southern Germany, Austria. The whole African continent, north and south of Sahara, Tenerife, São Thomé, Principé, Madagascar, Aldabra, Comoro Is., Seychelles. All countries in the Oriental region; China, Japan, Philippines, Formosa; Hainan, New Guinea, Indonesia, New Caledonia, Solomon Is., Samoa. In Australia from Queensland, Prince of Wales Is. From both North and South America and Canada, Galapagos and most West Indian Islands, Cuba, Puerto Rico.

It has not been recorded from U.K., Northern Europe, Hawaii, New Zealand, and many Pacific Islands.

Material examined.

Lectotype ♀ (*zinckenella*), Sicily, Treits. 3456, BM slide no. 12121, in TM, Budapest. Holotype ♀ (*dymnusalis*), Sierra Leone, in BMNH. Lectotype ♂, (*anticalis*) St. Jago [Santiago] (*Darwin*), in BMNH. Holotype ♂ (*indicatalis*), S. Africa, in BMNH. Lectotype ♂ (*schisticolor*), Californ., *E. schisticolor* (*Grote*), 97, in BMNH. Holotype ♂ (*sabulinus*), Japan, in BMNH. Holotype ♂ (*hastiferella*), Grenada, in BMNH. Over 1000 specimens, mostly BMNH. 25 specimens, BPBM, Honolulu.

Etiella behrii (Zeller)

(Pl. 4, figs 19–22; Pl. 8, figs 55, 57; Pl. 9, figs 58–63; Pl. 10, fig. 76; Pl. 11, figs 81, 82; Pl. 12, fig. 84; Pl. 15, fig. 103)

Phycis behrii Zeller, 1848b : 883. LECTOTYPE ♀, Australia (BMNH), here designated [examined].

Alata consociella Walker, 1866 : 1724. Holotype ♀, Australia (BMNH) [examined].

Alata subaurella Walker, 1866 : 1724. LECTOTYPE ♂, Australia (BMNH), here designated [examined].

Etiella ochristrigella Ragonot, 1888 : 27, LECTOTYPE ♀, New Guinea (BMNH), here designated [examined]. **Syn. n.**
[*Etiella zinckenella* sensu auct., nec Zeller, misidentifications.]
Etiella zinckenella (Treitschke) sensu Shibuya, 1928 : 93, partim, misidentification.]
[*Etiella behrii* (Zeller) sensu Evans, 1952 : 181, misidentification.]

♂. Wing, 10–13 mm. Externally similar to *zinckenella* but often greyer and always with more black spots on the wings. Fore wing, pattern as in Pl. 4, figs 19–22.

Genitalia ♂ (Pl. 8, figs 55, 57; Pl. 9, figs 58–63). Differing from *zinckenella* in shape of valve, one costal process noticeably shorter than other (but not as short as in *chrysoporella*), juxta with long, slender, rather parallel-sided lobes. Aedeagus with more slender and smaller cornuti than *zinckenella*.

♀. Wing 8·5–12 mm. Similar to female *zinckenella*, more black spots on fore wing but otherwise difficult to separate externally.

Genitalia ♀ (Pl. 10, fig. 76; Pl. 11, figs 81, 82; Pl. 12, fig. 84; Pl. 15, fig. 103). Differing from all other species in the genus in having the secondary sac at the end of a long duct. Neck of ductus bursae short. Ductus seminalis with small spines in first part, opening near base of bursal sac (i.e. away from ductus bursae).

Discussion. This species has long been confused with *zinckenella* and the two cannot be reliably separated on external characters. In the male *behrii*, the process on the base of the antennal segment is larger than in *zinckenella* but both species can be easily separated on genitalic characters. *E. behrii* is wide spread in Australia and probably occurs in most of Indonesia although I have seen specimens from only a few of the islands. The Malayan and Formosan specimens are slightly darker than the Australian ones but the genitalia are similar. As with all species in the genus the darker colour tends to fade with the increasing age of the specimen. At present the species is known from the mainland of China only from a few specimens from Hong Kong. It will probably prove to be more widespread. Less variation was found in size of specimens of *behrii* than in *zinckenella*.

Biology. *E. behrii* has been bred from pods of Lucerne and Ground-nuts (both Leguminosae).

Distribution. Map 7. Australia, all states; New Guinea; New Hebrides; Malaya; Indonesia, Borneo, Tanimber; Formosa; Hong Kong.

Material examined.

Lectotype ♀ (*behrii*), Australia: Adelaide, BM slide no. 11163, in BMNH. Lectotype ♀ (*ochristrigella*), New Guinea: Port Moresby, x. 1887–i. 1888 (*Kowald*), BM slide no. 13248, in BMNH. Lectotype ♂, (*subaurella*), Australia: Sydney, BM slide no. 13240, in BMNH. Holotype ♀ (*consociella*), Australia: Moreton Bay, in BMNH. 72 specimens, BMNH. 42 specimens, ANIC, Canberra. 37 specimens, SAM, Adelaide. 25 specimens, BPBM, Honolulu.

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